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Using local knowledge and sustainable transport to promote a greener city: The case of Bucharest, Romania

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ABSTRACT

Cities undergoing climate change and rapid urbanization are faced with significant transformational processes that affect the environment and society, challenging them to become more sustainable and resilient. The promotion of nature-based solutions represents an efficient approach to meet sustainability targets in cities and improve the quality of life of citizens. The association of large components of green infrastructure, such as urban parks, with physical activity can counteract the sedentary lifestyle endemic to cities and improve the overall health and well-being of individuals (Carrus et al., 2013; Scopelliti et al., 2016). By promoting a sustainable means of transport and connecting green spaces within a highly urbanized city, bicycle lanes represent an effective tool for associating physical activity with nature in cities allowing bicycle users to benefit from the positive health effects of nature-based solutions. Our study focuses on the potential of bicycle lanes to improve functional connectivity among green spaces. We administered 820 questionnaires in 34 green spaces (i.e., urban parks) in Bucharest, Romania, to identify the factors influencing the use of bicycle lanes connecting urban parks and to understand which planning criteria for bicycle lanes are considered as the most important by park visitors. We applied binary and ordinal logistic regressions and found that the factors affecting bicycle lane use are illegally parked cars and lack of accessibility to urban parks. The criteria preferred by park visitors for bicycle lane planning are determined by experience level and frequency of bicycle use. To develop a functional and integrated bicycle lane network that can make cities healthier and more sustainable, policy makers are advised to engage in a public participatory process and focus on the needs of bicycle users.

1. Introduction

Mounting levels of urbanization in the last century have led to significant transformations of the environment in many cities, which have been further aggravated by climate change effects (Kammen and Sunter, 2016; Kelly and Zhu, 2016). Urbanization processes have also contributed to human health deterioration (Schnell et al., 2016), e.g., in the case of respiratory diseases (Zhou et al., 2015), and have facilitated a common sense of sedentary lifestyle (Normile, 2016). From the dependency on automobiles (Geller, 2003) to desk-bound jobs (Popkin, 1999) and reduced physical activity, such a sedentary lifestyle can undermine citizens' health and well-being (Deweerdt, 2016; Hodson, 2016).

To tackle the challenge of sustainable urbanization, cities need to become more resilient (Moran and Lopez, 2016; United Nations, 2016) through the planning of nature-based solutions (NBS) within a larger urban green infrastructure approach (Kabisch et al., 2016; Lafortezza and Giannico, 2017; van den Bosch and Sang, 2017; Lafortezza and Konijnendijk, 2018). NBS can contribute to achieving sustainability targets (Badiu et al., 2016) due to their relevance to the quality of environmental factors (Spanò et al., 2017). NBS provide a wide range of ecosystem services which, in turn, generate important health and resilience benefits (Gómez-Baggethun and Barton, 2013; Lafortezza and Chen, 2016; van den Bosch and Sang, 2017).

However, the benefits deriving from NBS within cities are strictly dependent on the spatial location of green spaces and their connectivity/

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accessibility (Ngom et al., 2016). The connectivity and access to NBS promote the mobility of residents (Artmann et al., 2017), allowing them to move across cities in a sustainable manner. The greater the connectivity of urban green spaces, the greater the capacity to provide ecosystem services (Hansen and Pauleit, 2014).

Bicycle lanes are an example of NBS that can be used to connect and access urban green spaces, thus enhancing overall human health and well-being (Carrus et al., 2013; Scopelliti et al., 2016; Lafortezza and Konijnendijk, 2018) and further a greener city. Bicycle lanes have proven to be an effective tool for increasing the connectivity of recreational green spaces. They promote sustainable transport (Midgley, 2011), contribute to the reduction of air pollutants (Grabow et al., 2012; Chen et al., 2016; Johansson et al., 2017) and can connect elements of NBS, such as urban parks, while maintaining their recreational function. Bicycle lanes can also foster a healthy behavior by promoting physical activity (Pucher and Dijkstra, 2003).

Numerous cities have begun to invest in cycling infrastructure and other means of transport (Nieuwenhuijsen and Khreis, 2016) to increase connectivity among urban green spaces. Examples include urban areas in The Netherlands, Germany and Denmark where decision-makers strongly advocate for the use of bicycles (Pucher and Buehler, 2008). The association of bicycle lanes with green spaces (e.g., urban parks) is mentioned in various studies (Bedimo-Rung et al., 2005; Santos et al., 2016). Topics mainly address the health benefits that bicycle riding provides (Pucher and Dijkstra, 2003). For example, Wolch et al. (2011) applied a growth curve model to identify the relationship between cases of obesity in children and access to urban parks or other recreational areas. The authors concluded that residents in proximity of urban parks (10–15 min by bicycle) have a lower probability of developing obesity. Cranz and Boland (2004) mention the use of bicycles as an important activity within recreational spaces, besides other social or cultural means of entertainment. Another topic frequently addressed in the literature is the adequate and efficient planning of bicycle lanes responding to user needs. Winters et al. (2011) have established that the presence of major junctions, level of safety, lighting and exclusive sections for users constitute important factors in the development of bicycle lanes.

However, most of the studies have focused on specific benefits associated with the use of bicycle lanes in cities without considering the issue within a larger spatial dimension (i.e., green infrastructure) and a multiple ecosystem services approach. Encouraging the use of bicycle lanes is a priority to achieve sustainability targets in cities (Newman and Jennings, 2012; Portney, 2013). Consequently, there is a need to explore local knowledge such as the factors that determine citizens' behavior in using bicycle lanes (as an example of NBS) and the multiple associated benefits.

Within this context, we developed a study with the overarching goal to understand the factors influencing the use of the bicycle as a means of sustainable transport in contemporary cities. We used the city of Bucharest, Romania (Eastern Europe), as a case study due to the rapid urbanization that is ongoing at the expense of local sustainability and resilience. We analyzed the factors that influence bicycle users' preferences and investigated the criteria used to plan new bicycle lanes connecting green spaces. In our analysis, we specifically focused on the concept of "functional" connectivity as the ability of bicycle users to transit between urban green spaces and perceive multiple benefits (i.e., health and well-being from recreation, socialization and physical activities). Results from this study, based on public perception and knowledge, may have policy and planning implications for developing new NBS to counter the effects of urbanization and climate change in the European continent (Mariani et al., 2016; Panno et al., 2017) and others worldwide.

2. Materials and methods

2.1. Study area

Bucharest is considered one of the most congested cities in Europe (Morar and Bertolini, 2013). It is located in a plain where the average summer temperature rises above 22 °C (Cheval et al., 2009). With a population density of more than 8000 inhabitants/km^2 and a total of over 1.9 million, the city is facing problems such as urban sprawl (Grădinaru et al., 2015), traffic congestion and air pollution (Pătroescu et al., 2009). As a consequence of economic development and the increase in number of private cars, the city's transport infrastructure is forced to withstand frequent traffic jams and an insufficient number of parking lots, often supplemented at the expense of green spaces. The transport infrastructure is 3404 km long (National Institute of Statistics, 2014) and bicycle lanes occupy approximately 58 km (1.7%), while the modal share of cycling is less than 5% (van den Noort et al., 2009). Twenty-three parks from a total of 60 are within a distance of 100 m from bicycle lanes. The lanes provide access to metropolitan parks, yet their presence on the outskirts of the city remains insufficient.

The surface area of the city's green spaces, including parks, has decreased as a result of land conversion into commercial or residential areas (Iojă et al., 2014). Urban parks occupy an area of 812 ha (3.3% of the total surface area) and are unevenly distributed within residential spaces (Iojă et al., 2010). Depending on the area and population serviced, urban parks are divided into metropolitan parks (> 5000 visitors per weekend day), municipal parks (between 2000 and 5000 visitors per weekend day), district parks (< 2000 visitors per weekend day) and transit parks (20% of the visitors on a weekend day are passers-by) (Iojă et al., 2011). For the study we selected a sample of 34 urban parks (representing 86% of the total surface area of Bucharest's urban parks) (Iojă et al., 2011) that fall within the four aforementioned categories – 6 metropolitan, 10 municipal, 10 district, and 8 transit parks – with an even spatial distribution in Bucharest (Fig. 1).

To gather information on (1) the level of bicycle use and the factors that influence the use of existing bicycle lanes as well as (2) the relevant criteria for bicycle lane planning, we applied a questionnaire in all 34 urban parks. Bicycle users were asked to respond to 18 items of a 3-point Likert scale (1, low importance – 3, high importance) (Tyrväinen et al., 2014). The items covered the users' profile (frequency of use, experience), purpose of visit, elements of attraction, route preferences, perceived problems and limiting factors and bicycle lane planning criteria. The questionnaire was administered to the sample of urban park visitors (all respondents traveled by bicycle to the park) in two different stages during the March-May 2016 time period. To ensure a sufficient flow of respondents, the questionnaires were administered from 10:00 a.m. to 8:00 p.m. on days with favorable weather conditions, as required by the methodology (Sanesi and Chiarello, 2006; Iojă et al., 2011). Eight hundred and twenty questionnaires were distributed and administered in proportion to the importance and size of the parks: 40 in metropolitan parks, 30 in municipal parks, 20 in district parks and 10 in transit parks. Of the total, 687 questionnaires were considered valid, containing replies for all 18 items, and included in the analysis.

2.2. Identifying the factors influencing the use of bicycle lanes in Bucharest's urban parks

Binary logistic regression (Hosmer et al., 2013) was used to identify the factors that influence the use of existing bicycle lanes. This methodology is used to test whether the use of existing bicycle lanes can be predicted from 6 factors identified as issues in the urban landscape. Within the model, the dependent variable is represented by the use of existing bicycle lanes while the explanatory variables are types of factors that cyclists assessed as being of high, medium, or low importance. The factors we considered are the following: a) insufficient lanes to access urban parks; b) lack of accessibility to urban parks; c) illegally parked cars on bicycle lanes; d) conflicts with pedestrians; e) speed limits; and f) no connectivity to urban parks. The selection of independent variables was based on a scientific literature analysis (Dill and Voros, 2007; Parkin et al., 2007).

We checked the overall fit of the model to ascertain if the model

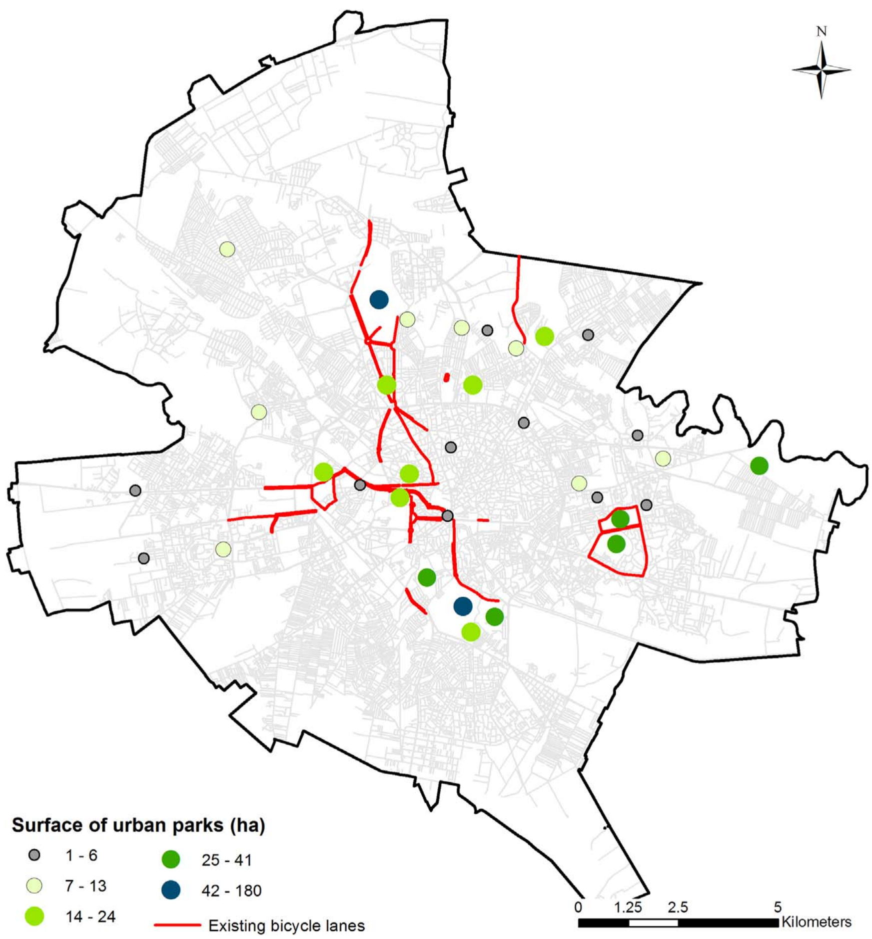

Fig. 1. Distribution of urban parks considered in the analysis of the study area.

with the predictors entered was more effective in predicting the outcomes than when applying the constant alone (Field, 2009). We also considered Nagelkerke's R^2 to determine how well our model predicted the outcomes (where a value closer to 1 means a better predictive power), goodness-of-fit (Hosmer et al., 2013) and overall success rate (Ho, 2013). We interpreted the results using the odds ratio measure which offers information about the change in the odds with a unit change in the predictor (Field, 2009).

2.3. *Understanding the perception of park visitors on planning criteria for bicycle lanes*

Ordinal logistic regression was employed to analyze whether *experience level*, *purpose for biking* and *frequency of use* could explain how criteria for planning bicycle lanes are valued. Ordinal logistic regression is used to test if the *experience level*, *purpose for biking* and *frequency of use* can predict how a bicycle user values certain planning criteria. We developed 10 regression models in which each of the 10 criteria, respectively, was treated as a dependent variable (Table 1). In each model, the independent variable was represented by the level of cyclist experience (classified as: 0–2 years, 2–5, 5–10 and over 10 years), purpose for biking (classified as: recreational, training, transportation), and frequency of bicycle use (classified as: daily, 2–3 times/week, 2–3 times/month, several times a year). We checked the overall fit of our model and Nagelkerke's R^2 against the predictive power of the model (where a value closer to 1 means a better predictive power). We analyzed the results using the odds ratio measure. All statistical analyses were performed using SPSS Statistics 20 (IBM Corp, 2011).

3. Results

3.1. *Factors determining bicycle lane use as a connector of Bucharest's urban parks*

The resulting binary logistic regression model produced a 61.3% overall success rate of correctly predicted values for the factors that determine bicycle lane use. Nagelkerke's R^2 value indicates that the model explained 9% of the variation in outcome. The insufficiency of bicycle lanes was an important explanatory factor in the model (Table 2). The odds ratio of using the existing lanes increased by a factor of 10.892 for the park visitors who considered the insufficiency of lanes of high importance in comparison with those who did not. The probability of using existing bicycle lanes decreased by a factor of 0.998 for the cyclists who considered low accessibility to urban parks of high importance compared with those who considered this factor as not important. The park visitors who perceived illegally parked cars on bicycle lanes to be a factor of high importance were 0.377 times less likely to use the existing lanes than those who believed this factor not to be important. The probability of using existing bicycle lanes also decreased by a factor of 0.301 for cyclists who identified illegally parked cars to be of medium importance. The odds ratio of using existing bicycle lanes increased for those who considered factors like conflicts with pedestrians (OR = 1.979, $p < 0.05$) of high or medium importance. The odds ratio of using existing bicycle lanes increased for those who perceived lack of connectivity as a factor of high importance (OR = 1.769, $p < 0.05$) in comparison with park visitors who attributed low importance to this factor.

Table 1
Established criteria for planning bicycle lanes.

Type of criteria	Planning criteria for bicycle lanes	Justification
City layout	Density of crossroads	The high density of crossroads improves overall connectivity of the road network. Crossroads can also affect the mobility and experience of bicycle users by increasing the probability of accidents (Rietveld and Daniel, 2004).
	Distribution of bridges	The presence of bridges on bicycle routes can be considered unfavorable for commuting cyclists. Bridges are either narrow (Aultman-Hall et al., 1997) or do not provide separate zones for cyclists (Broach et al., 2012). Riding over bridges can increase the effort or speed of cyclists beyond their comfort level.
	Distribution of subway stations	Planning for bicycle lanes using a complementary means of public transport, such as subway networks, can increase the use of both. Bicycle users have the possibility of covering longer distances to access urban parks or other recreational spaces (Pucher and Buehler, 2009). Bicycle transportation is permitted in Romania's subway system.
	Distribution of urban parks	We used the concept of graph theory (Minor and Urban, 2008) and considered urban parks as nodes and streets that constitute links for connectivity. Urban parks were considered as nodes or habitats that can provide space for recreational activities.
	Slope	The slope can be considered a negative criterion for planning bicycle lanes. High slope values lead to greater effort on the part of bicycle users or increased speed beyond the rider's comfort level (Gonzalo-Orden et al., 2014).
Design	Distribution of parking facilities	Parking spaces for bicycles are one of the important facilities to consider in bicycle lane planning, especially if they can ensure bicycle safety (Yang et al., 2015).
	Obstacles along the route	Obstacles along bicycle lanes due to urban infrastructure can cause accidents to users (Schepers and den Brinker, 2011) and should be considered during the planning process.
	On-street development	The on-street development of bicycle lanes can ensure improved connectivity compared with off-street lanes, even though the latter allow for a safer journey (Lusk et al., 2011).
	Presence of separation poles	Separation poles provide a net division from street traffic and can contribute to a safer bicycle ride (National Association of City Transportation Officials, 2014).
	Presence of street trees along bicycle lanes	Street trees and other natural elements are considered important for physical activity, such as walking and biking, because they contribute to the comfort of residents (Pikora et al., 2003).

3.2. Explanatory factors of planning criteria for bicycle lanes

Our logistic regression analysis identified the explanatory factors for bicycle lane planning criteria. All 10 ordinal logistic regression models had better explanatory power with the inclusion of predictors than with the outcomes alone (Table 3). However, only 7 models produced statistically significant variables.

The cyclists that use a bicycle with a frequency of 2–3 times/week or 2–3 times/month were less likely to consider *density of crossroads* of high importance compared with those who use it daily or very rarely. The odds ratio of considering *density of crossroads* as an important criterion increased by a factor of 1.748 for the cyclists with 0–2 years' experience ($p = 0.008$) (Table 4). The *distribution of parking facilities* was less likely to be weighed as an important criterion by those who use the bicycle 2–3 times/month. The odds of being considered an important criterion increased by a factor of 1.511 ($p = 0.037$) for the park visitors with a low-to-medium experience level of 2–5 years. For those with low and medium biking experience, the odds of considering the *distribution of subway stations* as an important criteria for planning bicycle lanes increased by a factor of 1.813 ($p = 0.005$) and 1.841 ($p = 0.002$), respectively. *Urban parks* were an important planning criterion for cyclists with 2–5 years' experience compared to those with a lower experience level. Regarding the development of bicycle lanes on the street, cyclists that use a bicycle less frequently than those who use it daily were less likely to consider *on-street development* as an important criterion. Similarly, the *presence of separation poles* was not considered an important planning criterion for those who use a bicycle 2–3 times/week, 2–3 times/month, or several times a year in comparison with those who use it daily. The odds ratio of considering the *presence of street trees* as an important criterion decreased by a factor of 0.652 for park visitors with an experience level of 0–2 years. Cyclists that use a bicycle 2–3 times/month also considered the *presence of street trees* as a less important criterion for planning. Respondents did not consider the criteria *distribution of bridges*, *obstacles along the route* and *slope* to be important. According to our model, only cyclists' experience level and frequency of bicycle lane use resulted as statistically significant explanatory variables, whereas the purpose for using the lanes was not significant.

4. Discussion

The results of this study provide important insights on bicycle lane use in a large European city and the knowledge required for improving connectivity between urban green spaces to promote human health and

Table 2
Main factors associated with the decreased use of bicycle lanes.

Variables	B	SE	*p*-value	Odds ratio	95% Confidence interval for odds ratio	
					Lower	Upper
Insufficiency of lanes: high importance	2.388	0.685	0.000	10.892	2.843	41.734
Insufficiency of lanes: medium importance	2.087	0.680	0.002	8.060	2.125	30.574
Lack of accessibility to urban parks: high importance	− 0.002	0.291	0.995	0.998	0.565	1.764
Lack of accessibility to urban parks: medium importance	− 0.044	0.262	0.867	0.957	0.572	1.600
Illegally parked cars: high importance	− 0.976	0.391	0.012	0.377	0.175	0.810
Illegally parked cars: medium importance	− 1.200	0.393	0.002	0.301	0.139	0.651
Conflicts with pedestrians: high importance	0.683	0.341	0.045	1.979	1.015	3.860
Conflicts with pedestrians: medium importance	0.788	0.339	0.020	2.199	1.131	4.276
Speed limits: high importance	0.272	0.247	0.271	1.312	0.809	2.129
Speed limits: medium importance	0.230	0.214	0.282	1.258	0.828	1.913
No connectivity: high importance	0.570	0.254	0.025	1.769	1.074	2.913
No connectivity: medium importance	0.145	0.221	0.511	1.156	0.750	1.783
Constant	− 2.556	0.706	0.000	0.078		

N.B. The reference category for all dummy coding was low importance. B = regression coefficient; SE = standard error of regression coefficient.

Table 3
Parameters of the ordinal logistic regression model.

Parameter/model		1	2	3	4	5	6	7	8	9	10
-2LL	Intercept only	335.1	316.5	323.9	310.8	330.5	318.7	272.2	311.2	319.0	330.8
	Final	314.5	313.4	303.5	297.1	326.0	303.9	260.8	278.7	304.1	313.6
Nagelkerke's R^2		0.034	0.005	0.033	0.023	0.007	0.024	0.020	0.055	0.024	0.028

Model based on 1: Density of crossroads; 2: Distribution of bridges; 3: Distribution of subway stations; 4: Distribution of urban parks; 5: Slope; 6: Distribution of parking facilities; 7: Obstacles along the route; 8: On-street development; 9: Presence of separation poles; and 10: Presence of street trees along the lanes.
− 2LL (multiplied log-likelihood): statistic used to assess the fit of the model (a lower value of the − 2LL of the final model in comparison with the intercept only model means a better predictive power).
Nagelkerke's R^2: statistic used to assess the fit of the model (a value closer to 1 means a better predictive power).

well-being. We discovered that the most important factors affecting mobility on bicycle lanes are illegally parked cars and lack of accessibility to urban green spaces. In addition, the criteria preferred by park visitors for developing a new bicycle infrastructure are determined by biking experience and frequency of bicycle use.

4.1. Factors influencing mobility on bicycle lanes

The insufficiency of bicycle lanes is considered a relevant factor influencing mobility only for cyclists that use existing lanes and experience the deficient network in Bucharest. Also, one of the main reasons for not using the existing bicycle lanes is the difficulty in accessing urban green spaces through these lanes. Considering that the availability and continuity of bicycle lanes influence the frequency of use (Dill and Voros, 2007), people are not inclined to use a fragmented and disconnected network even if it can provide a safer journey than cycling in traffic (Buehler and Pucher, 2012).

Illegally parked cars on existing bicycle lanes is considered a relevant factor that determines cyclists' avoidance of these lanes. Analogously to disrupted continuity of existing bicycle lanes, illegally parked cars lead to user discomfort and impede cyclists' mobility. Our results are complementary to the findings of Parkin et al. (2007), who report that cyclists also consider the increased risk of accidents and route disruptions caused by illegally parked cars.

Although visitors of green spaces consider conflicts with pedestrians, speed limits, and lack of lane connectivity as important limiting factors, they still use existing bicycle lanes as points of access. This behavior can be explained by the fact that bicycle lanes provide safety for cyclists, especially those who are inexperienced (Buehler and Pucher, 2012). Furthermore, the use of bicycle lanes is often associated with recreation rather than transportation (Aultman-Hall et al., 1997); this perception can explain why speed limits and conflicts with pedestrians are not considered as constraints.

Overall, existing bicycle lanes are still used regardless of their deficiencies. Cyclists valued most of the factors as very important and addressing them accordingly could help encourage bicycle use, both as a sustainable means of transport as well as an instrument of connectivity between urban green spaces. Considered as a sign of sound practice in the context of sustainable planning and policy, a well-designed bicycle lane network offers safe and comfortable transportation to cyclists (Pucher and Buehler, 2008).

4.2. Planning for a connected network of green spaces

The analysis we conducted has shown that the experience and frequency of bicycle use determine how a planning criterion is valued among visitors of green spaces. The high density of crossroads can be a stressful factor in riding a bicycle because it increases the risk of accidents (Vandenbulcke et al., 2009). This can explain why cyclists with less experience considered this criterion as very important for planning bicycle lanes. Experienced cyclists who frequently use a bicycle have a different perspective than occasional users and do not regard the high density of crossroads as a drawback. This may be attributed to the presence of intersections that allow for a high degree of continuity, making the urban area easily accessible (Jiang and Claramunt, 2004) and offering diverse routes to reach urban green spaces.

Parking facilities are also an essential component of a bicycle infrastructure and are very important for cyclists who have accumulated an experience level of more than 2 years, use the bicycle with a high frequency, and have understood the need of a safe parking place. According to Buehler (2012), who found a correlation between bicycle parking and higher levels of bicycle commuting, the presence of parking facilities can increase the use of this type of sustainable transportation. Based on these findings, bicycle lane planning should not focus so much on the distribution of parking facilities. Rather, parking facilities should be established after the network has been developed and in areas most accessed by cyclists.

Considering subway stations when planning for a bicycle infrastructure network is very important for inexperienced bicycle users. This type of visitor may regard the subway as a solution to avoid traffic and access urban green spaces more conveniently. Both means of travel can be used to cover large distances and promote a greener city. Our argument is supported by other studies and policies that advocate for a complementary use of both bicycles and public transportation to limit the increasing number of private cars (Martens, 2007).

The development of bicycle lanes on the street, instead of on the sidewalk, and with separation poles are considered very important factors for daily users that have more experience riding in traffic. Contrary to our results, other studies have found that off-street bicycle lanes are preferred by cyclists instead of on-street lanes (Winters and Teschke, 2010; Broach et al., 2012). The most common argument supporting off-street lanes is the safer travel conditions (Lusk et al., 2011). The different preferences for bicycle lane location can be explained by the cyclist's profile, city dimension, or traffic intensity. More research is needed to explore different perceptions on the design and location of bicycle lanes by relating them to the surrounding environment and the cyclist's profile.

Implementing street trees along bicycle lanes increases the experience and comfort of cyclists by mitigating high temperatures in summer (Sanesi et al., 2011; Mariani et al., 2016) and filtering air pollutants (Bolund and Hunhammar, 1999). However, the inexperienced cyclist with a low frequency of use neither perceives the effects of street trees, or other NBS, on his/her physical comfort nor their presence as essential for planning bicycle lanes. Frequency of use is the determining factor in this context.

Our study highlights the importance of urban green spaces mostly for bicycle users with a low-to-medium level of experience. This can be explained by the fact that inexperienced users find it difficult to access recreational areas outside the city and, therefore, rely mostly on urban green spaces closest to their homes (McCormack et al., 2010). Urban green spaces are resourceful for recreation and social interaction (Chiesura, 2004); they are also an essential factor for encouraging physical activity (Kaczynski and Henderson, 2007) and a healthy lifestyle (Tzoulas et al., 2007). Considering that people feel more comfortable cycling in pleasant landscapes rather than built-up areas (Nasar, 2008), associating urban green spaces with a bicycle

Table 4
Factors explaining the planning criteria for bicycle lanes.

Model/dependent variable	Explanatory variable	Odds ratio	95% Confidence interval for odds ratio		p-value
			Lower	Upper	
Density of crossroads	Daily	1.000	–	–	–
	2–3 times/week	0.586	0.393	0.874	0.009
	2–3 times/month	0.541	0.353	0.829	0.005
	Several times a year	0.949	0.560	1.607	0.845
	0–2 years' experience	1.748	1.160	2.634	0.008
	2–5 years' experience	1.444	0.981	2.125	0.063
	5–10 years' experience	1.000	–	–	–
	> 10 years' experience	1.340	0.870	2.064	0.185
Distribution of parking facilities	Daily	1.000	–	–	–
	2–3 times/week	0.672	0.449	1.006	0.053
	2–3 times/month	0.500	0.325	0.770	0.002
	Several times a year	0.734	0.431	1.248	0.254
	0–2 years' experience	1.215	0.808	1.826	0.350
	2–5 years' experience	1.511	1.026	2.227	0.037
	5–10 years' experience	1.000	–	–	–
	> 10 years' experience	1.171	0.760	1.805	0.474
Distribution of subway stations	Daily	1.000	–	–	–
	2–3 times/week	0.811	0.543	1.212	0.307
	2–3 times/month	0.714	0.464	1.099	0.126
	Several times a year	1.181	0.697	2.001	0.536
	0–2 years' experience	1.813	1.195	2.751	0.005
	2–5 years' experience	1.841	1.241	2.731	0.002
	5–10 years' experience	1.000	–	–	–
	> 10 years' experience	1.133	0.728	1.765	0.580
Distribution of urban parks	Daily	1.000	–	–	–
	2–3 times/week	1.084	0.726	1.618	0.693
	2–3 times/month	0.687	0.448	1.054	0.085
	Several times a year	0.702	0.413	1.192	0.190
	0–2 years' experience	1.288	0.855	1.941	0.226
	2–5 years' experience	1.452	0.985	2.141	0.060
	5–10 years' experience	1.000	–	–	–
	> 10 years' experience	1.060	0.687	1.634	0.793
On-street development	Daily	1.000	–	–	–
	2–3 times/week	0.429	0.266	0.693	0.001
	2–3 times/month	0.305	0.185	0.503	0.000
	Several times a year	0.315	0.174	0.570	0.000
	0–2 years' experience	0.801	0.518	1.240	0.319
	2–5 years' experience	0.886	0.583	1.348	0.573
	5–10 years' experience	1.000	–	–	–
	> 10 years' experience	0.966	0.597	1.566	0.890
Presence of separation poles	Daily	1.000	–	–	–
	2–3 times/week	0.652	0.434	0.979	0.039
	2–3 times/month	0.527	0.342	0.813	0.004
	Several times a year	0.585	0.343	0.996	0.048
	0–2 years' experience	0.941	0.625	1.417	0.771
	2–5 years' experience	0.811	0.551	1.194	0.288
	5–10 years' experience	1.000	–	–	–
	> 10 years' experience	1.011	0.653	1.565	0.962
Presence of street trees along bicycle lanes	Daily	1.000	–	–	–
	2–3 times/week	0.974	0.650	1.460	0.898
	2–3 times/month	0.527	0.375	0.889	0.013
	Several times a year	0.634	0.372	1.080	0.094
	0–2 years' experience	0.652	1.038	2.378	0.033
	2–5 years' experience	1.131	0.767	1.668	0.535
	5–10 years' experience	1.000	–	–	–
	> 10 years' experience	1.152	0.745	1.782	0.525

N.B. The dependent variable was considered as 1 = low-to-medium importance or 2 = medium-to-high importance.

infrastructure can promote sustainable transportation and improve overall connectivity and well-being.

Bucharest is an important example of urban planning in an Eastern European post-Socialist city, where decisions and policies are developed according to a top-down approach with little public participation and use of local knowledge (Stringer et al., 2009). To date, the development of bicycle lanes has lacked participatory planning and has not focused on providing a connected and viable infrastructure network. Although the city master plan addresses the issue of more sustainable transportation and the municipality offers incentives to promote the purchase of bicycles, there is still a lack of transparency and large gap in communication between decision-makers and users. Hence, we emphasize the importance of stakeholder engagement to ensure high mobility between urban green spaces.

Our study shows that appropriately integrated infrastructure improves the connectivity of urban green spaces and that citizens' opinion in this context is key for reaping the related health benefits. We highlight the concept that developing a functional bicycle lane network integrated with NBS can make cities greener and more sustainable.

The results of our study are also conclusive for other European cities that experienced a transition from the Socialist regime and are currently facing similar issues (i.e., traffic congestion, air pollution and the

urban heat island) (Simeonova and van der Valk, 2016). In this case, decision-makers can use the knowledge provided by our study to develop a coherent bicycle network, based on residents' needs, and help to mitigate the factors that place human health at risk.

This study has strong implications not only for decision-makers, who should promote local knowledge or public participatory processes and focus on user needs, but also for those who are active in the fields of public health, sociology, urban ecology and planning as well as private associations. These representatives need to understand the importance of the environment–public health nexus and of developing tools and policies that promote physical activity within urban green spaces (Markevych et al., 2017). Only through a close collaboration among these different disciplines can we increase knowledge and fill in the gaps (Panagopoulos et al., 2016), aiding city officials and planners to address human needs accordingly within an urban environment impacted by climate change.

5. Conclusions

Our study provides a practical approach towards identifying the issues and planning criteria that park visitors associate with bicycle infrastructure. We found that evaluating park visitors' perspectives can enhance the knowledge required for planning and ensuring a bicycle network that is efficient and in accordance with their needs. The literature offers numerous guidelines for building a sustainable urban bicycle infrastructure; our study has made its contribution by emphasizing the importance of planning based on user preference, experience and frequency of bicycle use.

Building a bicycle lane network to increase urban green space connectivity and encourage sustainable transportation should follow an articulated process. Consideration should be given not only to the standard criteria mentioned in research studies or reports but also to social aspects, such as age distribution and recreational needs; public participation is key. Promoting NBS, such as green spaces, represents another efficient approach to meet urban sustainability targets and improve the quality of life and well-being of citizens.

We believe that the topic covered in our study promotes the use of a sustainable means of transportation through NBS by emphasizing the importance of public consultation or participation. Even though the bicycle is commonly used in many urban settings, there still are cities that lack a comprehensive plan for developing a coherent bicycle network. Our study fills this gap by showing that the planning of urban bicycle lanes must take into account the experiences and needs of all cyclists in order to build functional and integrated networks.

Of particular relevance is the fact that bicycle lanes represent an effective tool for associating physical activity with green spaces, allowing bicycle users to benefit from the positive health effects of NBS. This is of utmost importance at a time when urbanization is rapidly advancing and cities are challenged to become more resilient and sustainable. It is our hope that this investigation will act as a springboard to advance further interdisciplinary research into the strong link between urban green spaces, public health, and sustainable cities in the face of climate change.

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